# Chapter 2 : Mechanical Design

## 1- Traditional Design:

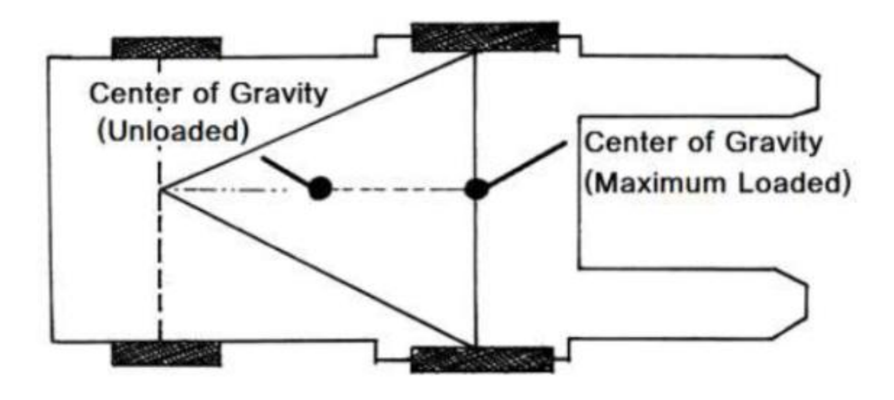



Figure_1

It's the old design of the commonly spread forklift truck, it uses an expensive theory that rises it's cost, and consumes some more power, that's the backward counter balance to maintain the center of gravity in a save position (The Triangle showed in figure_1) to prevent the truck from turning over the ground, However existing of that counter balance, many accidents occurred in many fields day after day, and there is no doubt that it needs also a perfect operator to prevent the truck from any damage.

In addition to the counter balance; the steering was achieved using a double rod cylinder mechanism, the suspension system was so complicate.

## 2- Design criteria:

In order to produce a cheap and more safe design, it was necessary to get rid of using the heavy counter balance, and to achieve this; it was no way except to add a smart technique that add a more unique degree of freedom to control the position Center of gravity.

This technique is a movable carriage which is moved forward and backward by a hydraulic cylinder.

Steering also occurring in a new way, it is done by a side way hydraulic cylinder which is linked in the backward and forward chassis, it's easier to steer the truck instead of using a double rod cylinder in the traditional design.

by this way more power is saved , simple and compact design is achieved and more cost is smartly saved.

## 3- Smart design:

This design consists of double part chassis like what's obvious in the book attachment, these double parts are connected together with a universal joint which has two degrees of freedom namely tilting, and steering.

Tilting means to make a vertical angle between the two chassis parts and steering means to make a horizontal angle between them.

The front part has the main two component; Mast and Carriage which they has two degrees of freedom, the first is up-downwards for mast (fig._4), the second is forward and backward for carriage (fig._5), these moves is achieved by lift cylinder and carriage cylinder respectively.

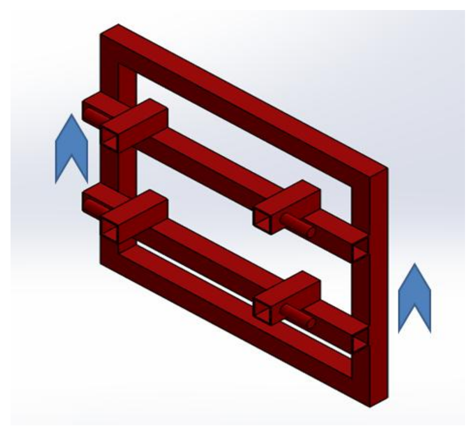




Figure_4

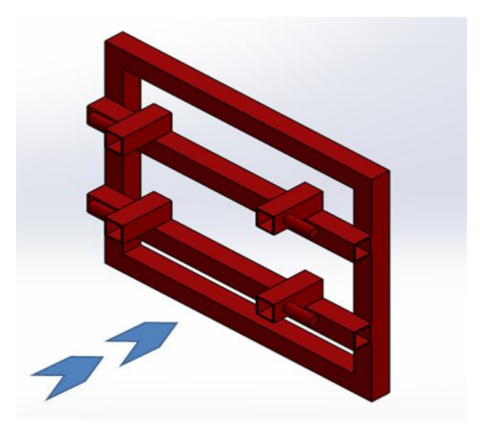


Figure_5

The connection between the two parts is on a universal joint, it supplies the project with a rotational motion in two directions, steering (figure_6) and tilting (figure_7).

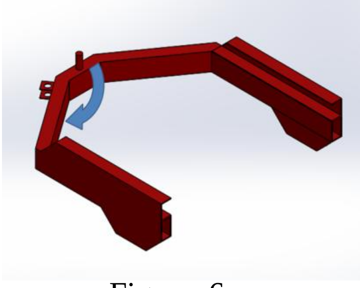


Figure_6

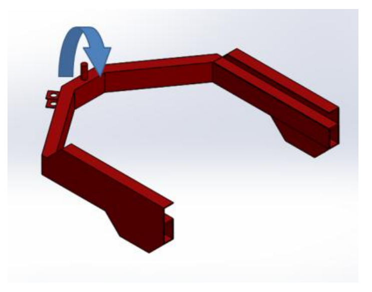


Figure_7

# Lifting process sequence

- Firstly, once load is lifted, the C.G is approximately on the mast plan.
- After lifting the load about (10 Cm) from the ground.
- Then It will be the tilting process turn.
- It's the time to pull the carriage about (20 Cm) backward, by that the C.G has transferred to a fully safe position.
- Finally the load can be lifted completely to reach the final height of about (150 Cm).

Now, Maximum weight can be calculated which can be lifted with the new design in a simple way assuming the initial C.G position on point (1) showed in figure_2 .

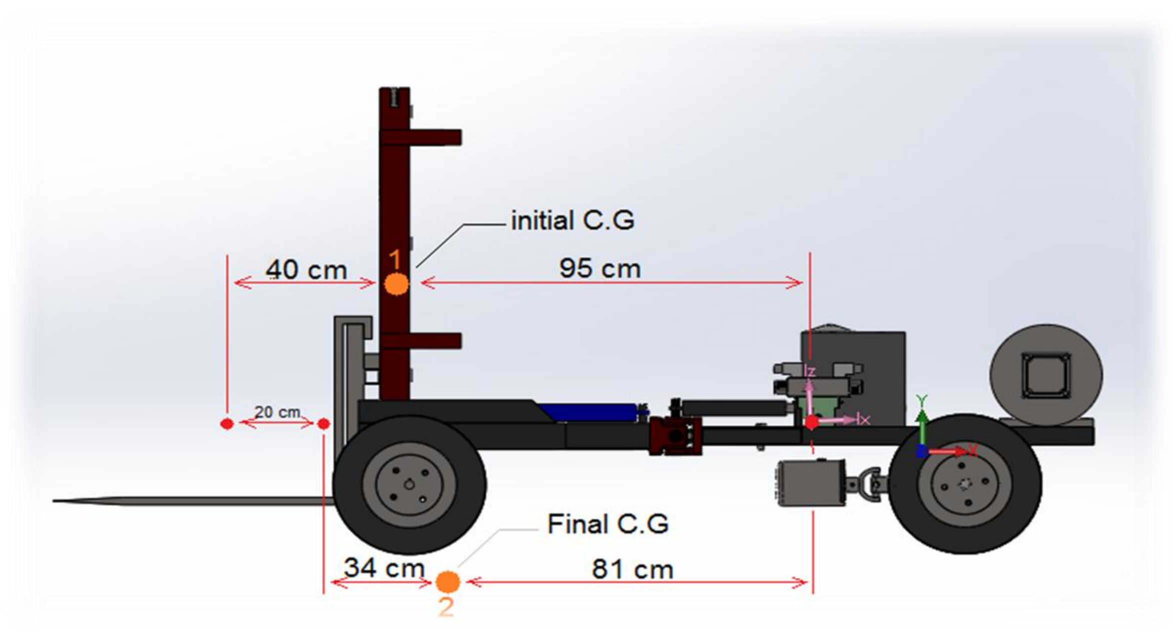



Figure_2

By taking the total moment around front wheel axis:

$$\text{Body weight} \times 0.95 = \text{Max. Load on forks} \times 0.4$$

where Body weight = 1500 N

So the maximum load on forks = 3560 N or 356 Kg

Then, final C.G position can be calculated from taking moment around an unknown point where the equivalent weight affects, immediately that point will be known as point (2) showed in figure_2, and it's distances from points where weights are affecting.

It's clear now that the final C.G is around (14 cm) behind front wheel axis, and the truck is in a full safety mode.

## PROJECT OVERVIEW

